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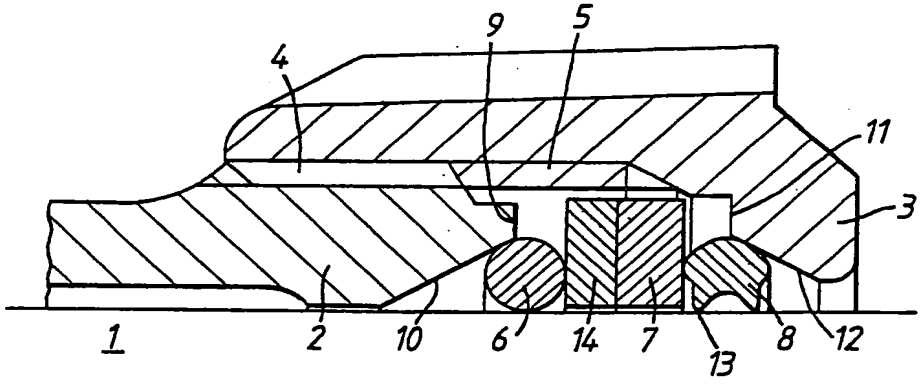

(57) Abstract

Fire resistant pipe couplings, the coupling comprising a coupling body (2) having an opening therein for receiving the pipe (1), a flexible gasket (6) for sealing the gap between the coupling body (2) and the pipe (1), and means (3) for urging the flexible gasket (6) into the gap, wherein the coupling includes a quantity of a fire-resistant material (14) which, when heated to a temperature substantially above that encountered in the normal use of the coupling, expands sufficiently to seal the gap independently of the flexible gasket (6). The invention has particular applicability to pipe couplings for natural gas pipes.

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FIRE RESISTANT PIPE COUPLINGS

The present invention relates to fire resistant pipe couplings.

By the term "coupling" as used herein is meant any coupling, junction, joint or fitting which can be fitted around a pipe, whether smooth or threaded, for the purpose of providing a fluid-tight connection between the pipe and some other piece of equipment such as one or more other pipes, meters, vessels, valves and the like.

Frequently to effect the fluid seal in pipe couplings a flexible gasket, such as a rubber 'O' ring, is used which is held in place by means of clamping bolts, compression nuts, tensioned metal bands, and the like. Although under normal conditions of use such seals are very effective, when subjected to high temperatures such as in a fire the flexible gasket, which is generally made of an organic polymeric material, first softens, then shrinks and finally breaks down both chemically and structurally. The effect of shrinkage and break down in the seal is almost invariably to cause it to fail seriously, and even softening of the gasket can result in significant fluid leakage because of the tendency of the softened gasket to flow under the compressive forces that are encountered in such coupling seals.

Although a degree of fluid leakage can be tolerated both during and immediately after a fire for some of the fluids, such as water, steam and air, commonly used in domestic and industrial premises , a serious leakage of a flammable substance such as petrol, oil or natural gas in

such circumstances represents a major hazard to the fire and rescue services. This hazard is particularly prevalent where compression joints, rather than threaded joints, have been used, since the manufacturing tolerances of compression joints are generally larger than for threaded joints.

A number of fire resistant pipe couplings have been proposed such as those described in UK-A-1441207 and in US-A-3375016, but generally they are expensive to manufacture, are usually only suitable for pipes and couplings of relatively small manufacturing tolerances, and cannot cope easily with misalignment of the pipe and coupling. Furthermore the sealing systems of these couplings are not readily adaptable for threaded joints.

In accordance with the present invention there is provided a fire resistant coupling for a pipe comprising a coupling body having an opening therein for receiving the pipe, a flexible gasket for sealing the gap between the coupling body and the pipe, and means for urging the flexible gasket into the gap, wherein the coupling includes a quantity of a fire-resistant material which, when heated to a temperature substantially above that encountered in the normal use of the coupling, expands sufficiently to seal the said gap independently of the flexible gasket.

The fire resistant material can take a variety of forms, depending on the size and type of coupling used. For relatively large couplings the material can be used in the form of a paste which can be smeared or extruded from a gun around the gasket during assembly of the coupling. There is with this form of material, however, a degree

of uncertainty and inconsistency about the thickness of the material at points around the pipe in the completed coupling, since it will depend entirely upon the care with which the operative applies the material and joins the parts of the coupling together.

A preferred form of material is therefore a pre-formed semi-rigid sheet which can be cut into sections, or stamped out in the form of a washer, and fitted in the gap between the pipe and the coupling body during assembly of the coupling. Usually to impart strength to the material for easier manufacture and installation in a coupling, a backing layer of a similarly fire-resistant material such as fibre glass is needed.

Instead of the fire-resistant material taking the form of an extra separate component in the pipe coupling, it can, of course, be incorporated into one of the conventional components of the coupling. For example, the coupling body could be manufactured with a layer of the material of a uniform thickness already bonded to its inner surface which will be sealed by the gasket against the pipe. Again a backing layer can be included if found useful during the manufacturing process.

In one convenient arrangement the fire-resistant material is disposed in a layer on a pressure washer for transmitting the urging of the urging means to the flexible gasket, optionally the material being disposed so as to transmit the urging of the urging means to the flexible gasket.

It will be appreciated by those skilled in the art that the incorporation of such a fire-resistant material into a

pipe coupling can be effected easily for a wide variety of joints.

When in the form of a compression joint, the coupling body is adapted to receive a relatively smooth pipe and its opening is desirably defined by inwardly tapering surface for receiving the flexible gasket, the gasket preferably being a rubber 'O' ring. Generally it is desirable for a locking member, such as a pipe gripping ring, to be present for resisting the removal of the pipe from the coupling after assembly thereof, optionally the locking member transmitting the urging of the urging means to the flexible gasket. In the preferred embodiment the coupling body is threaded and the urging means comprises a correspondingly threaded compression nut having an opening therein for receiving the pipe, this opening being similarly defined by inwardly tapering surfaces for receiving the gripping ring.

The material of which the pipe and coupling body are made are not critical to the present invention, provided of course that such material can itself resist the effects of a fire without allowing the fluid it is carrying to leak appreciably. Examples of suitable materials are steel, bronze, malleable cast iron, ductile cast iron and a wide variety of non-ferrous metals. The pipe may be coated with paint or the like or uncoated. In the preferred embodiment, the pipe is of steel and the coupling body is of malleable cast iron.

The fire-resistant material is preferably intumescent and substantially inert with respect to the fluid normally passing through the pipe. In order to take over as the flexible gasket fails, the fire-resistant material is

selected so as to start to expand at a temperature below that at which the material of the flexible gasket starts to degrade, and more preferably below that at which the material of the flexible gasket starts to soften. One particularly suitable fire-resistant material comprises a mixture of a vermiculite and graphite.

One embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a sectional elevational view of a portion of a rotationally symmetrical pipe coupling of the present invention of the compression type in its partially assembled state, and

Figure 2 is a sectional elevational view of the same portion of the pipe coupling of Figure 1, but in its fully assembled state.

Referring first to Figure 1, a smooth round pipe 1 carries loosely on it a cylindrical coupling body 2 and an engaging compression nut 3, both of malleable cast iron. The body 2 is externally threaded at 4, whilst the nut 3 is correspondingly internally threaded at 5, Figure 1 showing the nut 3 partially screwed onto the body 2. Between the body 2 and the nut 3, the pipe 1 carries along its length a rubber 'O' ring 6, a flat steel pressure washer 7 and a steel locking ring 8. On one face of the washer 7 is bonded a layer of an intumescent fire-resistant material 14 as described more fully later.

The end face 9 of the body 2 is provided with an inward taper 10 to its pipe opening, against which taper the 'O' ring 6 is urged by the face of the flat washer 7 on which

the intumescent layer 14 is bonded when the nut 3 is screwed onto the body 2. Similarly the inner shoulder 11 of the pipe opening of the nut 3 is provided with an inward taper 12 against which the locking ring 8 is urged by the other, bare, face of the washer 7 when the nut 3 is screwed onto the body 2. In both cases the sizes and orientations of the tapers 10 and 12 relative to the 'O' ring 6 and locking ring 8, respectively, are such that the greater the tightening of the nut 3 onto the body 2 the harder will the 'O' ring 6 and locking ring 8 be urged against the pipe 1. Furthermore, the lengths of the tapers 10 and 12 are chosen so that the coupling can fit around pipes having diameters which can vary across a relative large range.

The locking ring 8 is generally 'C' shaped in cross-section with the ridges 13 formed by the points of the 'C' being inwardly directed so as to dig into and grip the pipe 1 when urged thereagainst. As can be seen, the outer lateral faces of the 'C' shaped locking ring are indented so as to provide sharper ridges 13 than would be the case if the faces were fully rounded. By providing sharp ridges the digging in of the locking ring is improved, particularly with a galvanised pipe. The locking ring 8 is radially expandable and contractible by being in the form of an incomplete circle, only extending about 325° around the pipe. This construction of locking ring, in combination with the taper 12 of the nut 3, allows the coupling not only to grip pipes of varying diameters but also to provide a considerable degree of rigidity to the final joint. Variations in the construction and operation of the locking ring 8 are described in UK-A-1530205 and EP-B-0073050.

On the side of the washer 7 facing the 'O' ring 6 and transmitting the compressive forces thereto, is a uniform layer of the intumescent fire-resistant material 14.

This material 14 is in the form of a plastically deformable solid which is bonded, via a backing sheet of glass fibre arranged as a fleece, concentrically to one face of the washer 7. A further layer can be bonded to the other face of the washer 7, i.e. that facing the locking ring 8, in order to increase the protection against leakage, but this is generally found not to be necessary, provided that the total amount of the material 14 on the one face of the washer 7 is sufficient, in relation to the size of the gap between the pipe 1 and the coupling body 2, to provide an effective seal in the event of a gasket-destroying fire. If for a particularly large gap additional intumescent material is required, and bonding a layer of intumescent material to the other side of the washer is unacceptable, then one or more extra layers of material can be added to overlay the single layer already bonded to the washer 7, which extra layer(s) can either be bonded to the existing single layer or fitted next to it on the pipe in the manner of a washer. If space permits a second washer 7 carrying its own bonded intumescent layer may even be used. The use of such additional intumescent material may also be indicated where for a particular size of pipe a relatively large gap is left between the ends of the locking ring 8 which may allow fluid to escape from beneath the washer 7.

As Figure 1 shows, the material 14 is of uniform thickness and extends across the whole face of the washer 7. One particularly suitable material that is currently available is that supplied for fire doors and windows under the

trade name "PYROSTRIP BSL". This commercial fire seal material is at present available in two grades, "500" and "750", the differences being that the former is nominally 1.8 mm thick whilst the latter is nominally 2.5 mm thick. Both are a mixture of treated activated graphite and vermiculite bonded with a neoprene rubber to a glass fibre fleece backing sheet. Both are water and chemical resistant and are therefore especially useful in pipe couplings for natural gas and water services. The latter grade is preferred since it is capable of generating a higher positive pressure on expansion.

Referring now to Figure 2, the effect of screwing the compression nut 3 tightly onto the coupling body 2 is firstly to force the 'O' ring 6 down the body opening taper 10 and into sealing engagement with the pipe 1 and the coupling body 2. Because the intumescent material 14 acts as a force transmitter and because it is plastically deformable, it is squeezed partially into the voids around the 'O' ring and around the coupling end face 9. It will be noted that the thickness of the material 14 is such as to prevent any direct contact between the washer 7 and the 'O' ring 6. Such direct contact is undesirable since it could give rise after a fire to a section of the gap between the pipe 1 and coupling body 2 not being completely filled, and thus sealed, by the expanded intumescent material.

Simultaneously with the forcing of the 'O' ring 6 down body opening taper 10, the locking ring 8 is forced down nut opening taper 12. As it is so forced it contracts against the pipe 1 and its ridges 13 dig into and thereby grip the pipe 1. It will be noted that even when the nut 3 is fully tightened its internal shoulder 11 does not

contact the washer 7. By maintaining such a gap all of the compressive force of the nut 3 is exerted through locking ring 8 and thereby ensures that maximum possible gripping of the pipe occurs. Similarly it will be noted that even when the nut 3 is fully tightened the washer 7 does not contact the coupling body end face 9. If contact were made it would reduce the force exerted on the 'O' ring 6 which holds it in sealing engagement with the pipe 1 and the coupling body 2.

It will thus be appreciated that the sealing of the compressed 'O' ring 6 on the one hand and the gripping of the pipe 1 by the locking ring 8 on the other are totally dependant on the axial forces being transmitted between the two by the washer 7 through the intumescent material 14. If in the course of a fire, those forces are lessened or even reduced to zero by the softening or decomposition of the 'O' ring 6, it is up to the intumescent material 14 to expand, to re-generate the pressure of the 'O' ring and to fill and seal any voids left by the deteriorating 'O' ring 6. The material also expands around the end face 9 of the body 2 and into some of the threads 4 and 5 thereby helping to seal and hold the joint rigid.

For water pipes the standard 'O' ring is a synthetic rubber designated "EPDM", whilst for gas pipes a nitrile rubber is used designated "NBR". Both of these rubbers soften at about 130°C and progressively deteriorate above about 200°C. By contrast, the intumescent material "PYROSTRIP BSL 750" starts to expand at 120°C and reaches full expansion by about 300°C. Being mainly graphite and vermiculite, the melting point of this material is extremely high. The positive pressure generated by this material is also sufficient to maintain

the rigidity of the joint and thereby prevent any bending or twisting of the pipe relative to the coupling resulting from the effects of a fire, which with prior art couplings can cause fluid leakage.

As with all good compression joints, the illustrated coupling can be fitted onto a pipe by simply pushing the coupling in a loosely assembled state onto the pipe and tightening the nut 3 relative to the body 2 up to the required torque. An important advantage of this coupling is however its ability to accommodate relatively large manufacturing tolerances and some degree of misalignment between coupling and pipe centre lines. Because of manufacturing tolerances, similar components will vary in size, the four main ones being pipe diameter, 'O' ring wall thickness, coupling body opening diameter and taper angle of the body opening.

In the "minimum compression" condition, i.e. the combination of minimum pipe diameter, minimum 'O' ring thickness, maximum body opening diameter and minimum opening taper angle, the plastic deformation of the intumescent material will large and the contact face between the 'O' ring and the material will be well away from the end face of the body inside the body.

By contrast in the "maximum compression" condition, i.e. the combination of maximum pipe diameter, maximum 'O' ring thickness, minimum body opening diameter and maximum opening taper angle, the plastic deformation of the intumescent material will be small and the contact face between the 'O' ring and the material will lie close to the end face of the body and only just inside.

By means of the illustrated arrangement of 'O' ring, pressure washer and locking ring, a substantially equal stress can be applied to the 'O' ring for a given nut-tightening torque despite variations in manufacturing tolerances. Furthermore, the locking ring, being radially expandable, will grip pipes equally despite variations in pipe diameter tolerances.

In addition the design of the illustrated coupling provides very good sealing in normal use and an acceptable level of sealing both during and after a fire at relatively low manufacturing and installations costs.

CLAIMS

1. A fire resistant coupling for a pipe comprising a coupling body having an opening therein for receiving the pipe, a flexible gasket for sealing the gap between the coupling body and the pipe, and means for urging the flexible gasket into the gap, wherein the coupling includes a quantity of a fire-resistant material which, when heated to a temperature substantially above that encountered in the normal use of the coupling, expands sufficiently to seal the gap independently of the flexible gasket.

2. A coupling as claimed in claim 1 wherein the fire-resistant material is disposed in a layer on a pressure washer for transmitting the urging of the urging means to the flexible gasket.

3. A coupling as claimed in claim 1 or claim 2 wherein the fire resistant material is disposed so as to transmit the urging of the urging means to the flexible gasket.

4. A coupling as claimed in any one of the preceding claims wherein the coupling body is adapted to receive a relatively smooth pipe and its opening is defined by inwardly tapering surface for receiving the flexible gasket.

5. A coupling as claimed in any one of the preceding claims wherein the flexible gasket is a rubber 'O' ring.

6. A coupling as claimed in any one of the preceding claims including a locking member for resisting the removal of the pipe from the coupling after assembly thereof.

7. A coupling as claimed in claim 6 wherein the locking member transmits the urging of the urging means to the flexible gasket.

8. A coupling as claimed in claim 6 or claim 7 wherein the locking member is in the form of a pipe gripping ring.

9. A coupling as claimed in any one of the preceding claims wherein the coupling body is threaded and the urging means comprises a correspondingly threaded compression nut having an opening therein for receiving the pipe.

10. A coupling as claimed in claim 9 when appendant to claim 8 wherein the opening for the compression nut is defined by inwardly tapering surfaces for receiving the gripping ring.

11. A coupling as claimed in any one of the preceding claims wherein the fire resistant material is intumescent.

12. A coupling as claimed in claim 11 wherein the fire-resistant material is substantially inert with respect to the fluid normally passing through the pipe.

13. A coupling as claimed in any one of the preceding claims wherein the fire-resistant material is selected so as to start to expand at a temperature below that at which the material of the flexible gasket starts to degrade.

14. A coupling as claimed in claim 13 wherein the fire-resistant material is selected so as to start to expand at a temperature below that at which the material of the flexible gasket starts to soften.

15. A coupling as claimed in any one of claims 11 to 14 wherein the fire-resistant material comprises a mixture of a vermiculite and graphite.

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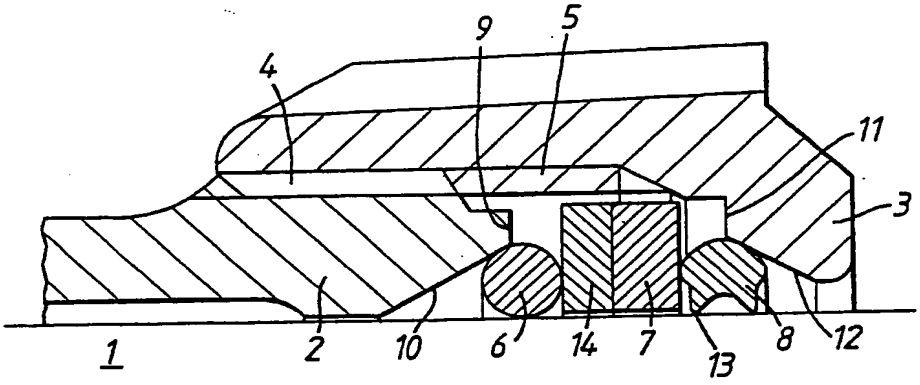

FIG.1.

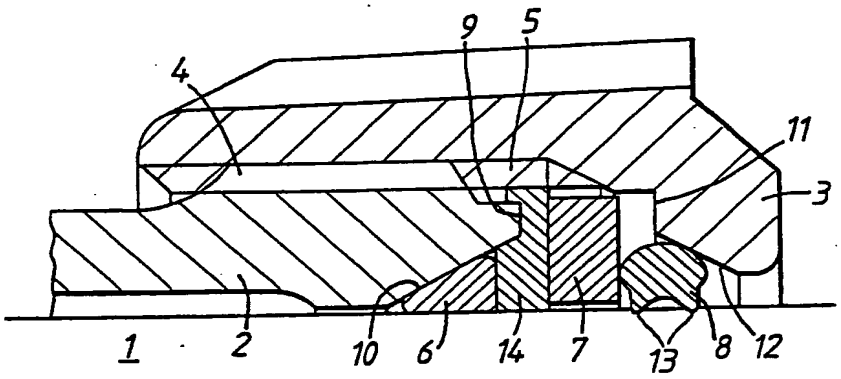

FIG.2.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 87/00873

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: F 16 L 19/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	F 16 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	EP, A, 0153564 (CHEMIE LINZ A.G.) 4 September 1985, see abstract; claim 1; figures	1,11
A	--	13,14
Y	EP, A, 0073050 (GEORG FISCHER AG) 2 March 1983, see abstract; figure 3	1,11
A	cited in the application	4,6,8,9
	--	
A	DE, A, 1927153 (A.F. HELLAND) 4 December 1969, see figures	5,6,8-10
	--	
A	GB, A, 1441207 (PRESSURE SCIENCE INC.) 30 June 1976 cited in the application	

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
25th February 1988	13 APR 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8700873 SA 19713

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 28/03/88
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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